Title: Squares in the Light

Brief Overview:

This lesson is designed for students to investigate the relationship between the length of the side of a square and its distance from the light source. A 2 cm square is cut from a 3" by 5" card and placed on an overhead projector. The students will then measure the side of the square projected on the overhead screen and the distance from the screen to the projector. This data will be tabulated, graphed, and analyzed.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
  Students will collect, display, and interpret data.

- **Mathematics as Communication**
  Students will express their results orally and in writing.

- **Mathematics as Reasoning**
  Students will demonstrate their ability to use inductive reasoning and reason from graphs.

- **Mathematical Connections**
  Students will observe the mathematical relationship involved in the concept dealing with the diffusion of light.

- **Patterns and Functions**
  Students will construct an algebraic model describing the diffusion behavior of light. They also will develop an algebraic function describing the data points in a table.

- **Algebra**
  Students will apply the concept of light diffusion to solve a real-world problem.

- **Measurement**
  Students will use standard measuring devices to obtain data.

- **Algebra**
  Students will apply theory and be motivated through the use of real-world problems. They will apply computer utilities to develop conceptual understanding.

Links to Maryland High School Mathematics Core Learning Goals:

- **1.1.1**
  The student will recognize, describe, and extend patterns and functional relationships that are expressed numerically, algebraically, and geometrically.

- **1.1.2**
  The student will represent patterns and functional relationships in a table, as a graph, and/or by mathematical expression.

- **2.1.2**
  The student will identify and verify properties of geometric figures using concepts from algebra and using the coordinate plane.

Links to Maryland High School Science Core Learning Goals:

- **1.7.4**
  The student will recognize mathematics as part of the scientific endeavor, comprehend the nature of mathematical thinking, and become familiar with key mathematical ideas and skills.

Grade/Level:

The unit is appropriate for grades 7 through 12. (Pre-Algebra/Algebra I).

Duration/Length:

This unit will take 2 days to complete.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Linear equations, function tables
- Graphing, measurement
- The scientific method

Objectives:

Students will be able to:

- collect and correctly interpret data from a table or graph.
- identify a linear function.
- utilize a calculator to graph a function.

Materials/Resources/Printed Materials:

- TI-81/82/83/85 calculator
- Overhead projector and screen
- Meter sticks
- Scissors
- 3" x 5" index cards
- Copies of activities sheets

Development/Procedures:

Teacher will have students work in groups of 2, 3, or 4 as routinely assigned.

Teacher will give a brief overview of the experiment to make sure students understand the procedures as listed on the activity worksheet.

Teacher will demonstrate and review the correct process for entering data and drawing a scatter plot with the graphing calculator.

Students will complete Activity Worksheet #1 first. When the assignment is completed, students will do Activity Worksheet #2.

Students will discuss conclusions through oral presentations.

Teacher will collect the completed activity sheets to assign a final grade.

Performance Assessment:

Students will plot answers on a separate graph paper, briefly noting the content premises of how they arrived at final assumptions.

Students will write important facts, logistical finding, and personal thoughts in their journals.

Teacher will circulate among groups to monitor students' understanding of the assignment.

Extension/Follow Up:

Students will use the CBL (Computer Based Laboratory) with the light probe in correlation with an overhead projector to generate further analysis. Once the light activity is completed, students could try an experiment with sound to see if the results will be similar.

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STUDENT ACTIVITY SHEET #1

Diffusion of Light Worksheet

Introduction:
Ms.Smith, your teacher, is having trouble setting up her classroom for the new school year. She owns an extremely heavy overhead projector table which, because of its weight, must be placed correctly **the first time**. She has asked you to help her calculate the ideal distance for the projector so that light fills the screen exactly.

Problem: How does the distance from a screen affect the size of the projected image?

Background Information:

Independent variable- This is the quantity that the experimenter carefully adjusts. It is always graphed on the x-axis.

Dependent variable- This is the quantity that the experimenter measures after he has changed the independent variable. It is always graphed on the y-axis.

Question Set A:

1. What is the independent variable (quantity) for this experiment?
2. What is the dependent variable (quantity) for this experiment?
3. Label the following axes and draw a curve that matches your guess for how your data will appear:

Hypothesis:
(This is a statement of how the independent variable affects the dependent variable.)
Complete the following hypothesis with your educated guess.

The _____ will increase/decrease (circle one) as the
dependent variable

_____ increases/decreases (circle one).
independent variable

Materials:

- •TI-81/82/83/85 calculator
- •Overhead projector and screen
- •Meter stick
- •Scissors
- •3" x 5" index card
- •Copy of activities sheets

Procedure:

1. Cut a 2 cm square approximately in the center of the 3" x 5" card.
2. Place the card on the lighted overhead projector.
3. Focus the overhead projector on the screen. Measure the distance from the overhead projector to the screen. Record this distance in the data table.
4. Measure the side of the projected square image on the screen. Record this measurement in the corresponding blank of the data table.
5. Increase the distance between projector and screen. Repeat steps 3 and 4.
6. Repeat step 5 at least four more times to complete the data chart.

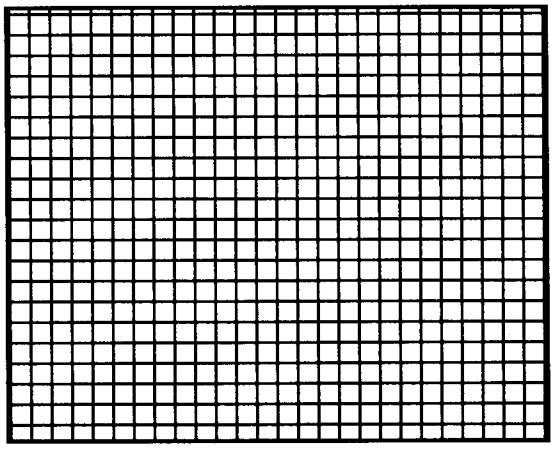
Data:

Image Projection Data for a 2 cm Square

Trial	Distance (cm)	Image size (cm)
1		
2		
3		
4		
5		

Graphing:

1. Graph the above data on the following grid. Be sure to include a title, all necessary labels. Pay particular attention to the scales for the x and y axes.



2. Compare your data graph with the curve you drew in question #3 from Question set A. How are they similar? How are they different?

_____
_____
_____
_____

Graphing with a TI-82/83/85 Graphing Calculator

a. To enter your data into the calculator press **[STAT] [1] .**
b. Enter the 'distance' data into list 1. Remember to press **[ENTER]** after each number.
c. Cursor over to the top of list 2 by pressing the **[>]** key.
d. Enter the 'image size' data into list 2. Remember to press **[ENTER]** after each number.
e. Turn on your statistical plot by pressing the **[2nd] [Y=] [1]** keys. Choose the scatter plot from your menu choices.
f. Display the graph by pressing **[ZOOM] [9]**.

3. Compare your data graph with the scatter plot in the calculator. How are they similar? How are they different?

_____
_____
_____
_____

4. According to your data, how far was the projector from the screen when the 2 cm image was tripled in size? Explain the method you used to arrive at your answer. Show all necessary calculations.

_____
_____
_____
_____
_____
_____
_____
_____

5. Ms. Smith's overhead is 30 cm across. How far away from the screen must she place the overhead projector so that it completely fills her 150 cm screen? Explain the method you used to arrive at your answer. Show all necessary calculations.

_____
_____
_____
_____
_____
_____
_____
_____

STUDENT ACTIVITY SHEET #2

Moon Mission Worksheet

Name: _____ Period: __ Date: _____

Attention thrill seeker. You have been selected for a mission on the moon. Your mission, should you accept, is to collect rock samples for future studies. Listed in your itinerary is your specific assignment to solve. Good luck and safe travel.

1. The moon is smaller than the earth, so its gravitational pull is less than the earth's. An object on the moon weighs only one-sixth what it weighs on the earth.

   a. On the earth a person weighs 150 pounds. Find the person's weight on the moon.

   b. On the moon a lunar rover weighs 215 pounds. How much does it weigh on the earth?

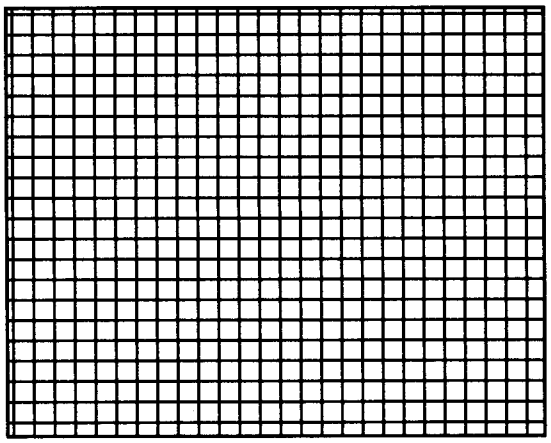
   c. Is the relationship between an object's weight on this planet and its weight on the moon proportional? Explain.

   d. Let x = an object's weight on the earth. Let y = an object's weight on the moon. Write y as a function of x.

   e. Make a table of values for the function.

earth weight	moon weight

f. Graph the function.



g. Is the function linear? Explain.[1]

1 Barbara Alcala and Cathy Seeley. (1998) Foundations of Algebra and Geometry. Menlo, California. Addison-Wesley Publications.